Coordinate Measuring Machines

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Coordinate Measuring Machines

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Overview

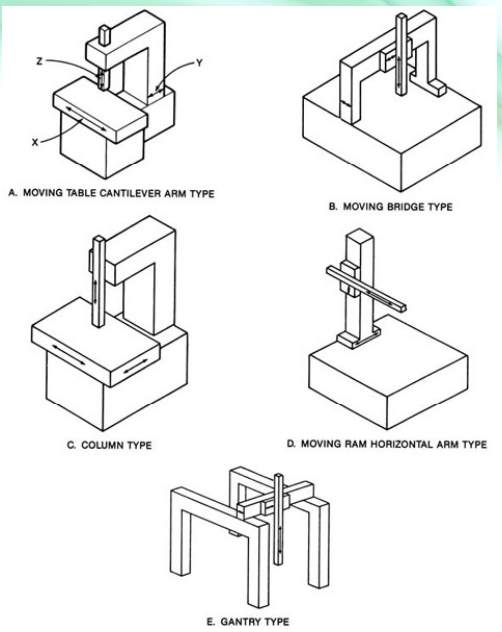
Coordinate Measuring Machines (CMMs) are extremely powerful metrological instruments: they enable us to locate point coordinates on three-dimensional structures at the same time that they integrate both dimensions and the orthogonal relationships.
When we add a computer to the CMM, we create an instrument that can automatically perform complex analysis and that can learn measurement routines to compare how a piece conforms to its specifications. Instead of performing time consuming measurement with traditional, single axis instruments (micrometers, height gages, etc.) and cumbersome mathematics, you can dimensionally evaluate complex workpieces with precision and speed and you can store the data for later analysis or comparisons. The greater the complexity of the piece, the greater the benefits from a CMM.

The Role of Coordinate Measuring Machines

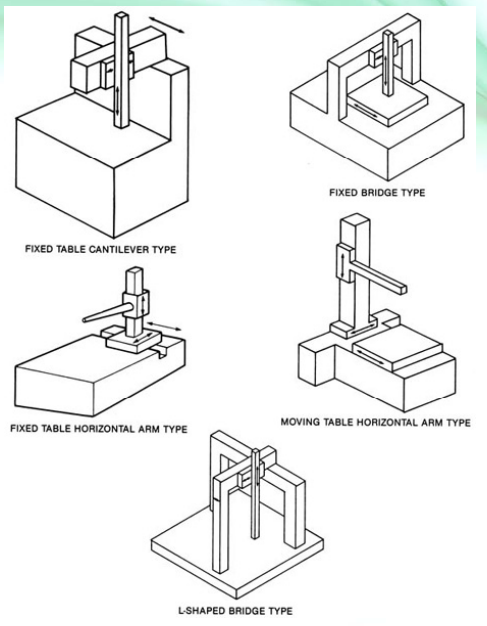
CMMs are particularly suited for the following conditions:

- Short runs—We may be producing hundreds or even thousands of a part, but the production run is not sufficient to justify the cost of production inspection tooling.
- Multiple features—When we have a number of features—both dimensional and geometric—to control, CMM is the instrument that makes control easy and economical.
- Flexibility—Because we can choose the application of the CMM system, we can also do short runs and measure multiple features.
- High unit cost—Because reworking or scrapping is costly, CMM systems significantly increase the production of acceptable parts.
- Production interruption—Whenever you have to inspect and pass one part before you can start machining on the next part, a machining center may actually be able to help a manufacturer save more money by reducing down time than would be saved by inspection.

Types of Coordinate Measuring Machines



Types of Coordinate Measuring Machines

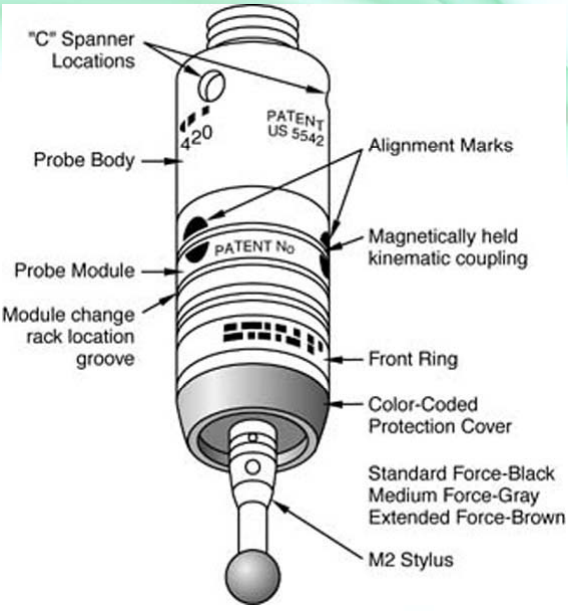


Modes of Operation

Although there are nearly as many modes of operation as there are CMMs, they can be divided into general categories:

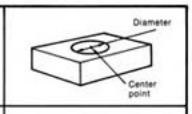
1. Manual
2. Manual computer assisted
3. Motorized computer assisted
4. Direct computer controlled (DCC)

Modes of Operation

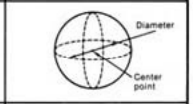


Modes of Operation

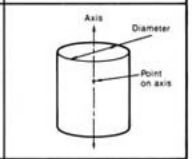
A **Multiple circle**
Using a minimum of three measured points, the program calculates the center point and diameter of the best-fit circle.



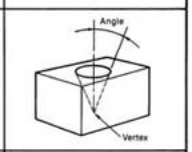
B **Multipoint sphere**
Using a minimum of four measured points, the program calculates the center point and diameter of the best-fit sphere.



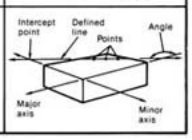
C **Multipoint cylinder**
Using a minumum of five measured points, the program determines the best-fit cylinder and calculates the diameter, a point on the axis, and a best-fit axis.



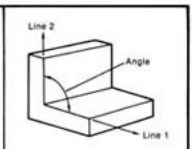
D **Cone calculate**
Using four measured points, the program determines the vertex, angle, and taper of an inside or outside surface of a cone. Taper is defined as the tangent of the angle.



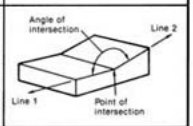
E **Multipoint line**
Using a minimum of two measured points, the program determines a best-fit line through those points. The point of intersection between the line and the major axis are calculated.



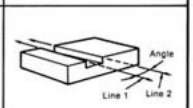
F **Perpendicularity of two lines**
Using a minimum of two measured points on each line, the program calculates the angle between the two lines. Perpendicularity is defined as the tangent of this angle.



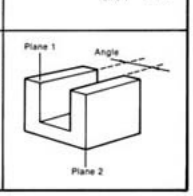
G **Angle/point of intersection of two coplanar lines**
Using a minimum of four measured points, the program calculates the point of intersection and the angle of intersection of two lines.



H **Parallelism of two lines**
Using a minimum of two measured points on each line, the program calculates the angle between the two lines. Parallelism is defined as the tangent of this angle.

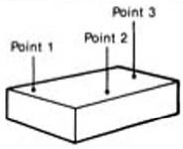


I **Parallelism of two planes**
The program calculates the angle between two planes. Parallelism is defined as the tangent of this angle.

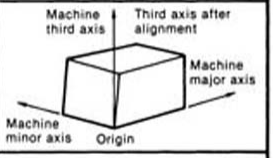


Modes of Operation

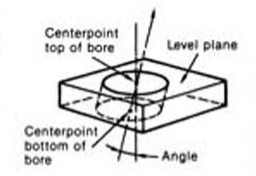
A **Multipoint plane**
The program determines the best-fit plane through a minimum of three measured points.



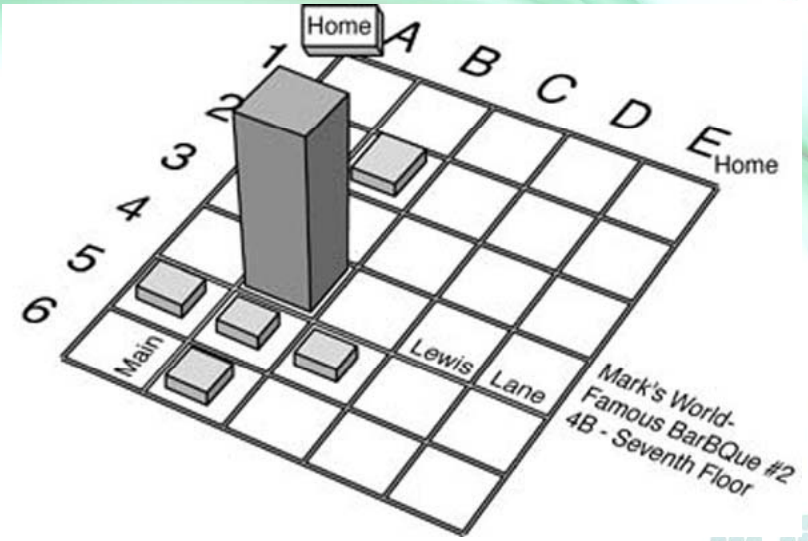
B **3D alignment**
The program aligns the third axis through a line determined by the part origin and a measured point on the part surface.



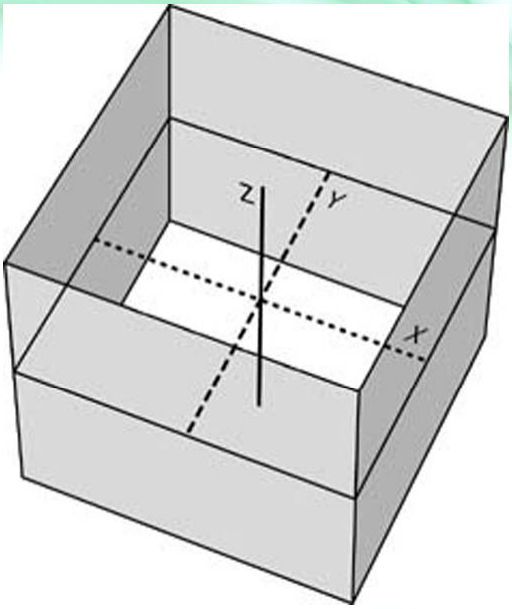
C **Perpendicularity of a bore axis to a plane**
The program calculates the angle between a bore's center line, established as a line between the bore's upper and lower center points, and the face of the bore. Perpendicularity is defined a the tangent of this angle.



Metrological Features

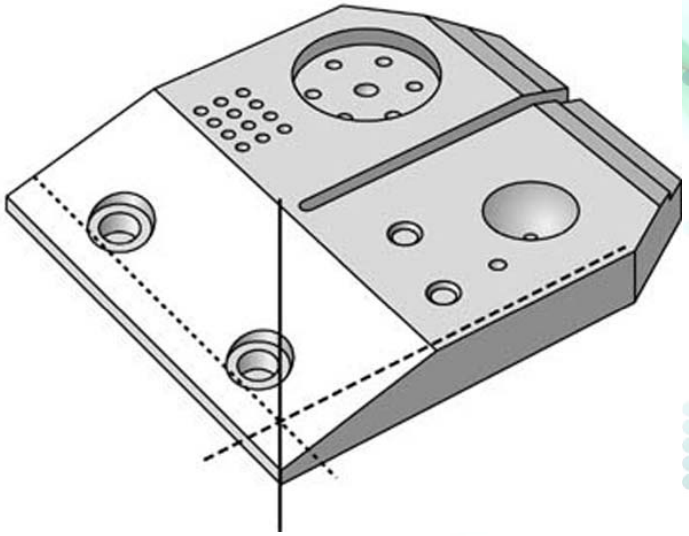


Metrological Features



Metrological Features

XY plane is upper surface of part.
Origin is lower right-hand corner of part.
X axis is aligned along front edge of part.



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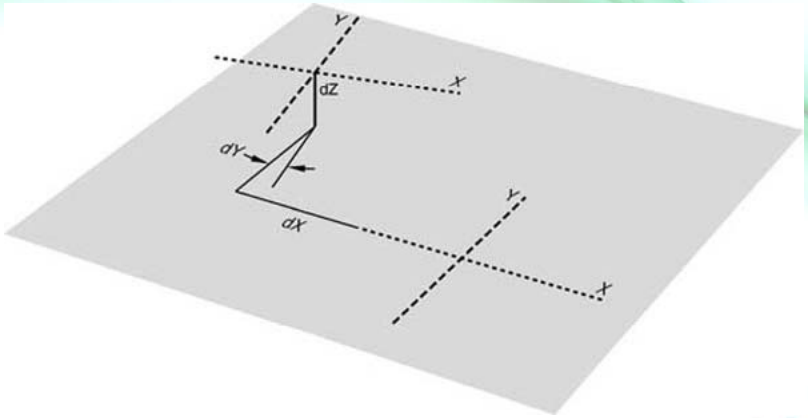

Video

Examples

Examples

Examples

Examples

Examples

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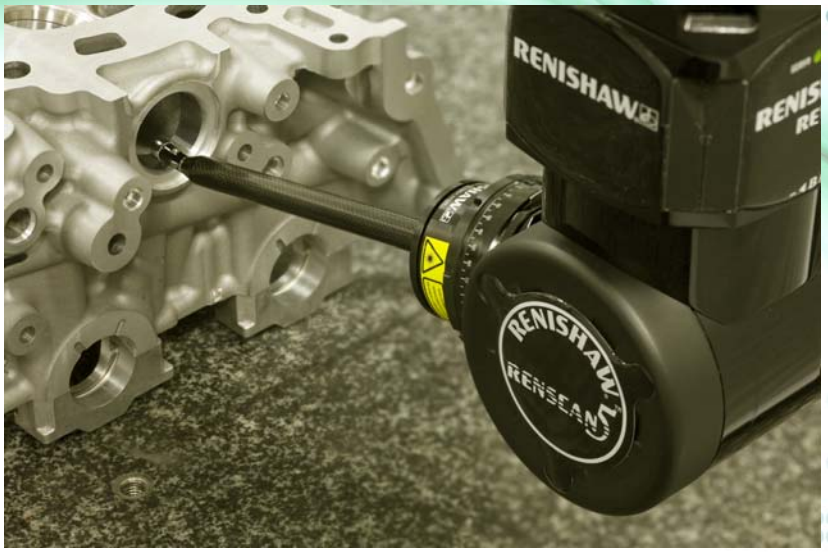

Examples

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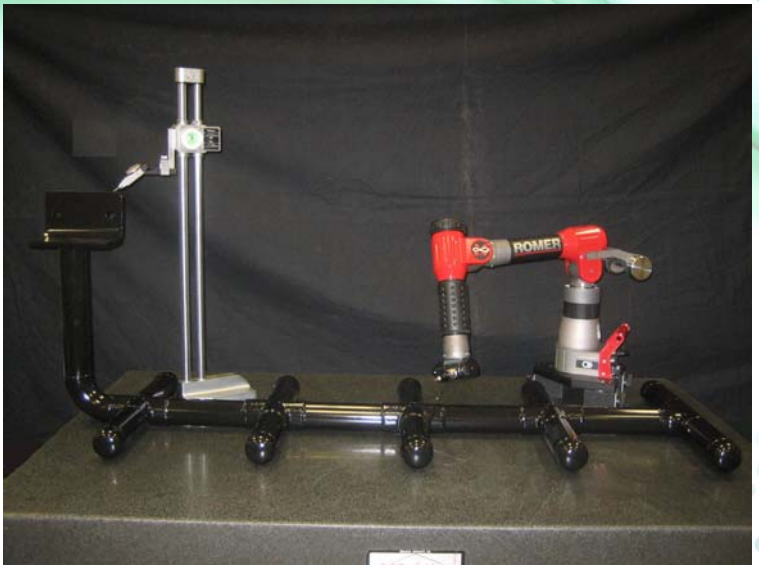

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